From a Restored Photograph to an Interactive Biography: A Protocol for Integrating Digital Humanities, AI, and Genomathematics

Case Study

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Abstract: Starting from a severely damaged portrait found in my family archives, I conducted a three-step process combining image restoration, archival investigation, and augmented storytelling. The restored face becomes the entry point to an embodied biography: text, images, maps, and a clearly labeled synthetic voice converge to bring forth a living memory. I situate this practice within Digital Humanities (scholarly editing, visualization, accessibility) and within my research in genomathematics (here, “reconstructions”). Lacking access to this man’s autosomal and Y-chromosome DNA (with the sole exception of mitochondrial DNA via a nephew), the present inquiry relies exclusively on documentary archives, while showing how, in future work, written and biological archives can be brought into dialogue.

Keywords: digital humanities, image restoration, archives, paleography, Cologne, biography, accessibility, generative AI, mapping, 3D visualization, genomathematics, memory.

Step 1 — Restoring Presence

The primary goal is to **repair**, not to “beautify.” I sought to make a damaged face legible while preserving its documentary credibility. The rule is simple: enhance the visibility of information that is genuinely present in the image (light, contrast, perceived relief) **without** altering morphology or adding features that were never there. The result must remain a **restored testimony**, not an aesthetic reinterpretation.

Practically, I started from a faithful digital reproduction of the photograph and applied an **AI-assisted workflow followed by Photoshop** to reduce scratches, haze, and degradation while improving the readability of details. Each operation is documented step by step (process log and before/after comparisons) so that the work can be understood and, where appropriate, reproduced. When information was missing or too uncertain, I **left it incomplete** rather than “guessing.”

The **ethical boundary** of restoration was explicitly maintained: no correction was allowed to alter the subject’s identity (interpupillary distance, nasal width, lip line, hairline, etc.). Likewise, I avoided any “smoothed” or stylized rendering that would

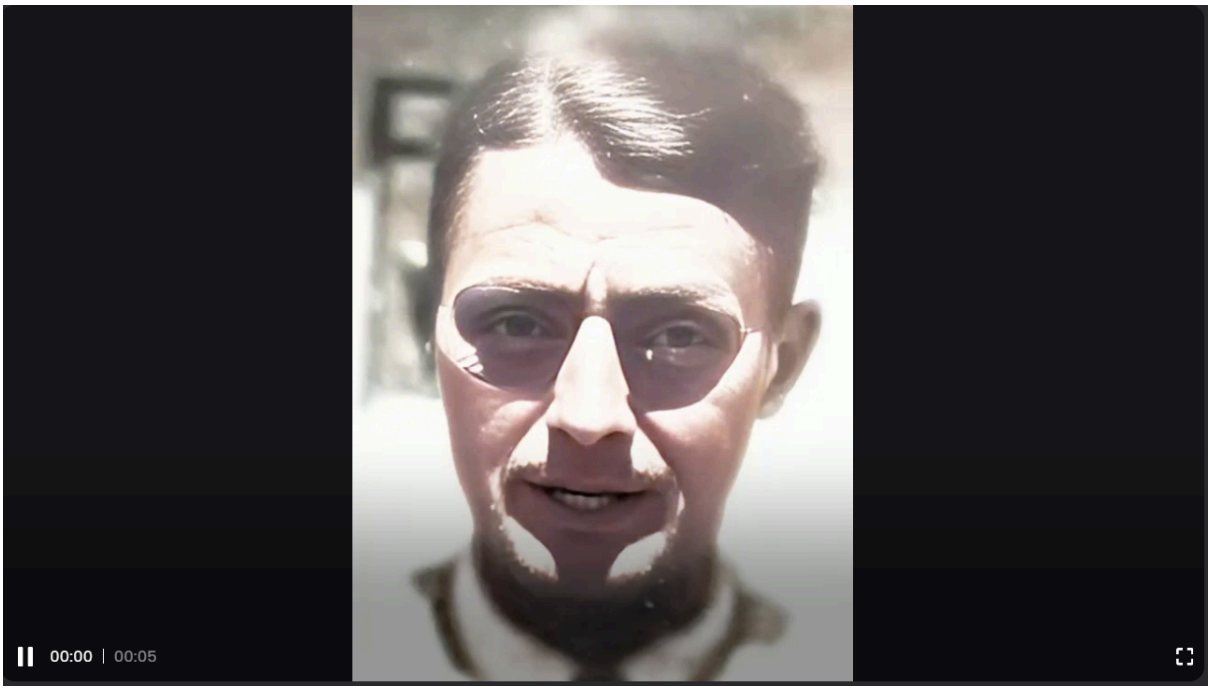
create an artificial look. Systematic version comparisons and third-party review served as safeguards against known AI biases (tendencies to homogenize skin textures, to rejuvenate, or to erase historical micro-blemishes).

In a second phase, I created short **animated sequences** from the restored face. These animations—**clearly labeled as synthetic**—are limited to plausible micro-movements (blinking, slight gaze shifts) and, where relevant, **lip-synced delivery** of a text strictly sourced from the archives. They are not meant to simulate emotions or statements that are not established. Their use remains **documentary and educational**; each export carries a visible notice indicating that it is **AI-generated**.

Transparency is central to this step. Along with the final image, I publish a **methodological note** summarizing the choices made, the limits encountered, and the criteria used to stop processing. The metadata specify the restorer, date, context, and the label **“digitally restored image.”** This framing enables readers to judge how much confidence to place in each visible detail and to distinguish what stems from **readability repair** from what remains **unknown**.

Digitally restored family photograph using artificial-intelligence tools and non-destructive editing; interventions were limited to correcting damage and improving legibility, with no alteration of morphology. Any derivative animations are

synthetic reconstructions for documentary purposes and are explicitly labeled as such.



Vidéo générée, séquence de 5 secondes à chaque fois, en utilisant différentes expressions faciales.

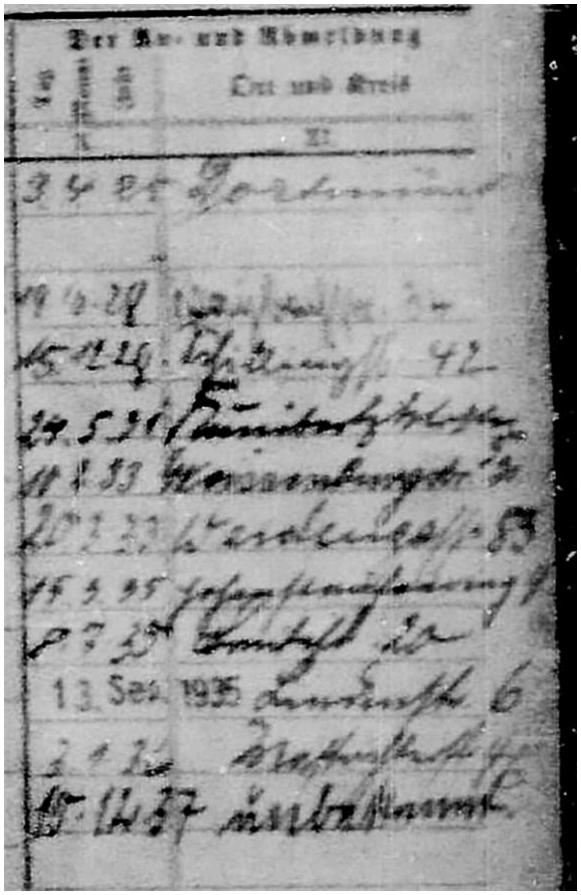
Step 2 — Recontextualizing through the Archives

An image only makes sense when it is inscribed within a life. Starting from the restored portrait, I set out to place this face back into a fabric of **verifiable facts**—places, dates, occupations, public events. The goal was not to build a "plausible" story, but to reconstruct a **documented trajectory**, prioritizing sources and making uncertainties explicit. I assembled a corpus of primary and secondary materials spanning the interwar and postwar periods, with careful attention to **traceability** (references, call numbers, digital copies, research log).

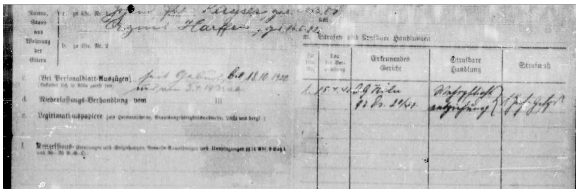
Reconstructing the **successive addresses** provided the chronological backbone. Using residential registrations and address directories (often akin to an informal census), I **geocoded** each location and, where available, compared these points with historical views. Some houses still stand today; others vanished in wartime destruction. This mapping reveals **continuities** (neighborhoods, professional proximities) and **ruptures** (sudden moves, forced departures), while offering a clear visualization of **lived space**.

In parallel, I tracked **occupations and status changes**. Professional directories, trade registers, and occasional notices in the local press supply milestones on activity, employers, and sometimes level of responsibility. Cross-referenced with addresses, these clues illuminate periods of economic stabilization or instability and help date certain documents more precisely. Because these sources carry biases

(update delays, omissions), each mention is accompanied by a **reliability note** and a reminder of the **context of production**.

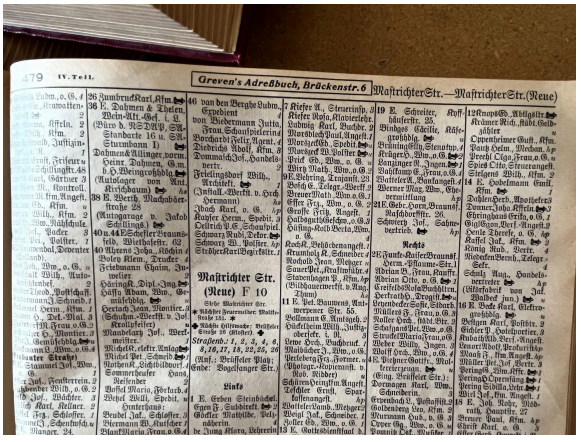


Artificial intelligence can help with paleography!



Cross-referencing sources: here, directories, **Meldekarten** (residence registration cards), and the criminal record.

German directories made it possible to find people by name or by address, with their occupation listed alongside. They function as a kind of census that historians in Germany now use to trace individuals from the pre-war period when certain archives have been destroyed.



The core of the investigation rests on administrative and judicial records: Meldekarten (residence registration cards), civil-status registers, military files, and excerpts of court decisions. These sources notably confirm a conviction by the Nazi authorities for “high treason,” a crucial point for understanding movements and biographical ruptures. Many of these documents are written in **Kurrent/Sütterlin**; their reading was assisted by AI tools (handwriting recognition and translation) and then **manually verified**. Each transcription is provided alongside the page image, a justification of reading choices in cases of ambiguity, and an associated **degree of uncertainty**. This dual approach—digital assistance plus human control—reduces decoding errors and makes the argumentation **verifiable**.

The archival work continued **in the field**. I visited Cologne's **NS-Dokumentationszentrum** (archives of the former Gestapo) to consult relevant holdings and contextualize the proceeding mentioned above. I also revisited the **1937 building** connected to his trajectory: it still stands, but now houses a shop. These back-and-forths between past and present add a **sensory dimension** without compromising rigor: they allow one to confront the document with the place, assess the plausibility of movements, and materially grasp what the texts suggest.

Former Gestapo cells and bunker in Cologne. August 2025.

A methodological component involved conducting a critical verification of family narratives. Oral traditions are valuable, but they require systematic scrutiny: active attempts at falsification, cross-checking testimonies against one another, and adjudication based on the quality of written sources (with priority given to records that are contemporary with the events, official, and independent). Several claims transmitted within the family proved inaccurate; correcting them—far from "diminishing" the person—made him more human by revealing the complexity of the political and social constraints of his time.

To ensure reproducibility, I kept a **research log** (dates, places of consultation, call numbers, links to reproductions, and reasons for choices) and am depositing with the article a **standardized inventory** of the materials used. Data that could identify living persons are anonymized or omitted, in line with good data-protection practices. Translations and transcriptions are accompanied by methodological notes specifying the degree of automation and the manual validations performed. Finally, a **synthetic**

chronological map (addresses, occupations, major events) is provided so that readers can follow the thread of the reconstruction and assess, step by step, the strength of the inferences.

Thus re-situated within the density of the archives, the photograph ceases to be a mere relic and becomes the entry point to a **documented narrative**. Image, places, occupations, and public decisions speak to one another; AI plays an **assistive** role (reading, organization, translation), while critical analysis guarantees the **probative framework**. It is within this dialogue—between visual trace and written evidence—that the restored presence of the face takes on its full meaning.

Step 3 — The Embodied Biography

From the corpus of verified documents, I construct a **first-person narrative** that follows a clear chronology and adheres strictly to attested facts: “I was born in 1913…,” “In 1937, I worked as…,” “I moved to No. X on Y Street…”. The choice of the first person does not aim to fictionalize the subject’s life, but to make intelligible and affectively accessible what the archives establish. Each sentence is anchored to an identified source; when information is uncertain, the narrative adopts **cautious phrasing** (“it is likely that…,” “the registers suggest that…”) with an explicit note reference. In this way, the narration combines **proximity** and **probity**: it renders the trajectory accessible without diluting documentary rigor.

The restored face then becomes a **vehicle of enunciation**. A **synthetic voice**, clearly identified as such from the outset, reads the text in a neutral, respectful diction, without dramatic amplification. This voice does not “incarnate” the person; it **conveys** a sourced and controlled text. The video’s introduction states the approach explicitly: “You are hearing a synthetic voice reading a narrative based on archival documents. No sentence goes beyond the established information.” This **paratext** protects the reader from misunderstandings and confines the use of animation and synthesis techniques to a **pedagogical and memorial** function.

To **situate** the life in space, the narrative is paired with an **interactive map** that unfolds addresses over the years. Each geolocated point opens onto a notice: dates of occupancy, type of dwelling, link to the relevant register extract, **period image** when available, and **current view** to gauge urban transformations (or the disappearance of a block). Readers can follow the residential trajectory as one follows a lifeline—identifying **stabilities** (neighborhood, professional proximity) and **ruptures** (sudden moves, political constraint). This spatial layer gives the biography a **sense of place**: one no longer reads only dates; one **walks the streets**.

The experience is complemented by street views (real or prudently reconstructed) that evoke everyday life: façade, courtyard, entrance, window alignment, proximity to a workshop or a tram line. These elements do not claim to “show” what once was; rather, they contextualize what the documents allow us to infer: a type of dwelling, an

urban atmosphere, a concrete distance between home and workplace. Any image that involves a degree of interpretation is labeled (“didactic reconstruction”) and accompanied by a note recalling its limits (sources used, gaps left open).

Taken together, the materials form an immersive, documented, and replicable narrative. Readers can move from the film (voice + restored face) to the map (residential trajectory), then to the notices (primary sources), and back to the continuous text. This circulation among image, place, and evidence constitutes a kind of augmented edition: the narrative does not ask to be believed; it invites verification. To facilitate reuse, the materials are provided with a methodological note (script structure, alignment between sentences and references, conventions for uncertainty), enabling other researchers or families to reproduce the approach with their own archives.

The “character” walking through the streets of Cologne in 1933, generated by an AI to which I provided his portrait. *This first-person narrative is based on archival documents cited in the notes. The voice is synthetic, and the animated face is derived from a restored photograph; these elements serve solely documentary and educational purposes. Any reconstructed image is labeled as such and accompanied by a note specifying its limitations.*

Accessibility is not an afterthought but a design component. The video is accompanied by a full transcript, synchronized captions, audio description of images,

and a downloadable text version that can be printed in braille or read by a screen reader. Still images include descriptive alt text; the map offers a list mode that reproduces the steps of the trajectory for users who cannot interact with a cartographic interface. This attention to accessibility extends the project's purpose: making memory shareable beyond each person's technical and sensory constraints.

Digital Humanities × Genomathematics

This project shows how **Digital Humanities** can transform a heterogeneous set of traces—images, registers, addresses, objects, oral accounts—into an **augmented edition of memory**. Far from a simple "montage," the task is to organize, annotate, and interlink fragments so that a **verifiable trajectory** emerges: each image points to a call number, each date to a record, each place to material or cartographic evidence. The value added by the digital is not spectacle but the **legibility of links** (who, when, where, on what basis) and the **traceability** of operations (what was restored, interpreted, or left blank). The restored photograph thus ceases to be an isolate: it becomes the **threshold** to a consultable evidentiary dossier.

"My" **genomathematics** follows the same logic on a different register: it treats **DNA as a coded text**, within which **multi-level numerical invariants** reveal regularities and symmetries, while controlled operations (mirrors, projections, consistency tests) allow us to explore **erased trajectories**. This approach does not oppose the biological to the cultural; it **puts them in conversation**. Written archives recount what institutions recorded; biological archives carry, in filigree, inheritances of kinship, migrations, and admixture. Both are **forms of memory** that require methods of reading, interpretive safeguards, and channels for transmission.

In the present case, **no genetic data are available**—not even via direct descendants (**except mtDNA from a nephew**). The inquiry therefore relies **exclusively** on written and visual archives. Far from being a problem, this limitation underscores the **complementarity** to come: when DNA is accessible (and ethically authorized), it can **confirm, nuance, or invalidate** hypotheses drawn from documents; when DNA is absent, **archival rigor** and **spatio-temporal modeling** remain fully operative. Conversely, however robust, genetic data are **mute without context**: civil status, residential trajectories, and professional and judicial statuses provide the **grammar** needed to interpret them.

Methodologically, the DH × genomathematics articulation rests on a few simple principles: **transparency** (state what is done and what is not), **reproducibility** (describe steps, provide comparisons, flag uncertainties), **interpretive restraint** (do not make the data say more than they bear), and an **ethic of memory** (documentary purpose, respect for persons, protection of the living). AI tools—whether assisting in reading old scripts or restoring a face—are presented as **assistants**; they do not have the final word. Truth remains the **convergence of independent sources**.

In practice, this synergy takes the form of a **layered digital edition**: (1) a **visual layer** (restored portrait, street views, period imagery); (2) a **documentary layer** (primary/secondary sources, call numbers, transcriptions, translations); (3) a **spatio-temporal layer** (address map, event chronology); (4) a **methodological layer** (process log, limits, choices); and, when feasible, (5) a **biological layer** (non-identifying lineage summaries, haplogroups, numerical invariants, with consent and ethics approval). Each layer is readable on its own, but it is their **nesting** that reveals the continuity of a life.

Beyond the individual case, the aim is programmatic: to offer a **toolkit** that other families, researchers, museums, or memory organizations can adopt. Digital Humanities provide the **editorial structure** (record templates, metadata schemas, narrative maps, accessibility); genomathematics provides a **formal language** for thinking the memory of the living without reducing it to biological determinism. Between the two lies a shared horizon: to **translate, connect, and transmit** traces—respecting their differences in nature—so that stories emerge that are **true because verifiable** and **alive because shareable**.

Why it matters

Preserving family history for future generations.
Memory fades quickly: witnesses pass away, media deteriorate, narratives warp. By organizing photos, addresses, occupations, and records into a clear digital edition, we fix **verifiable landmarks** and transmit a common foundation—dates, places, evidence—on which descendants can build. This is not mere storage; it is an **intelligible ordering** that resists time, forgetting, and obsolete formats, allowing anyone to recover the thread of a life without romanticizing it.

Honoring the forgotten or invisibilized.
To name, contextualize, and restore the complexity of a life is to **restore dignity**. Far from family myth or silence, a documented biography reveals the constraints of an era, the choices made, the risks taken—and at times the violence of institutions. This work does not idealize; it **re-humanizes**. Ordinary lives deserve a place in the collective record: they illuminate history from the ground up and remind us that “big” History is made of countless singular existences. This case study traces the fate of a German man who joined the **French Foreign Legion in Oran** and later fought Nazism. His story was rendered invisible after the war.

Experimenting with new forms of narration at the history / biology / digital interface.
Crossing archives, maps, a restored face, and a **clearly labeled** synthetic voice offers a narrative grammar suited to our time: **multimodal, traceable, and replicable**. It engages readers differently: one does not “consume” a story—one **investigates** it, clicking sources, checking call numbers, comparing period images.

And tomorrow, when ethics permit, documented DNA (haplogroups, shared segments) can **converse** with the civil file to confirm, nuance, or refute hypotheses—without reducing the person to biology.

Sharing a lived, sensitive, ethically framed memory.
Technology is not an end in itself; it is a **means of transmission**. Hence the safeguards: explicit labeling of generated content, refusal of sensationalism, protection of living persons, and accessibility (full transcript, captions, audio descriptions, braille/voice versions). This framing clarifies what is **seen** (restored image), what is **said** (sourced facts), and what is **reconstructed** (pedagogical animations). It establishes basic trust and, along the way, fosters a **critical culture of images and AI**.

A public good, not just a family project.
This protocol offers a **toolkit** that other families, teachers, museums, and memory organizations can adopt: structuring a dossier, writing a sourced narrative, publishing evidence, opening discussion. By anchoring each claim in a consultable trace, we strengthen **resilience against misinformation** and transform private memory into a **shareable good**.

Open question.
Would you like one day to have an ancestor **tell you their life**—with their own face and a **clearly labeled** synthetic voice—starting from an old photograph and a handful of rediscovered records? If the answer is yes, then this work is not only one man's story; it is a **method** for turning other lives into living memories.

Methods & tools (reproducible overview)

Restoration: exposure correction, non-destructive inpainting, denoising, resampling, color management; process log.

HTR/OCR & translation: reading of historical scripts (Kurrent/Sütterlin), toponymic disambiguation; glossary.

Mapping: geocoding of addresses, spatio-temporal timeline, story map.

Narration: sourced first-person script, clearly labeled synthetic voice, alternation of period views and current views.

Documentation: Dublin Core metadata, licensing, and full source traceability.

Ethics, rights, and safeguards

Transparent labeling of AI content.
All AI-generated elements (animated face, synthetic voice) are explicitly disclosed in

captions and notes. The intent is documentary and educational only—no illusion of reality.

Copyright and archival rights.
I respect the rights of photographers, rights-holders, and collecting institutions. Reproductions are used within their stated terms; third-party materials are credited, and licensing is clarified separately from the text and figures.

Memory sensitivities (Nazi period).
The material is handled with historical context, factual accuracy, and restraint. Sensationalism is avoided; claims are tied to verifiable records and carefully sourced.

Future use of genetic data.
Any prospective genetic work will require legal authorization, informed consent, prior ethics-committee review, and a documented chain of custody. No identifiable genetic data are used in the present study.

Other works by the author on Digital Humanities, genomathematics, and memory:

Kayser-Cuny, V. (2025). (Part IV) The Mirror-Twin Paradox: Resurrecting Faces, Reversing Genomes — 3D Facial Reconstruction through the Lens of the Mirror-Twin Hypothesis. Zenodo. https://doi.org/10.5281/zenodo.15565927

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Kayser-Cuny, V. (2025). Invariants numériques multi-échelles et propriétés fractales du code génétique : une analyse combinatoire et atomique. Zenodo. https://doi.org/10.5281/zenodo.17068705

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Kayser-Cuny, V. (2025). Le codex 97.1.128 : Mémoires d'un monde caché (compilation de trois nouvelles de science-fiction). Zenodo. https://doi.org/10.5281/zenodo.16886932